(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 354 479 B1**

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **13.07.94** (51) Int. Cl.[5]: **G01L 9/06**

(21) Application number: **89114367.9**

(22) Date of filing: **03.08.89**

(54) Semiconductor pressure sensor.

(30) Priority: **07.08.88 JP 197572/88**
21.06.89 JP 158715/89

(43) Date of publication of application:
14.02.90 Bulletin 90/07

(45) Publication of the grant of the patent:
13.07.94 Bulletin 94/28

(84) Designated Contracting States:
DE FR GB IT

(56) References cited:
EP-A- 0 167 144
DE-A- 3 146 870
US-A- 4 320 664

SOVIET INVENTIONS ILLUSTRATED, week D13, 6th May 1981, Derwent Publications Ltd, London, GB;& SU-A-746 217

PATENT ABSTRACTS OF JAPAN, vol. 12, no.137 (M-690)[2984], 26th April 1988;& JP-A-62 258 811

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EP 0 354 479 B1

Description

The present invention relates to a semiconductor pressure sensor for detecting a pressure of a medium to be measured.

As a device for measuring a high pressure medium, it is known that a pressure sensor disclosed in Japanese Laid Open Patent Publication No. 1987-293131 is available. As shown in Fig. 14, the pressure sensor is provided with a stick-like sensing portion 52 disposed in a cylindrical metal housing 51 and a sealing plate 53 which seals between the sensing portion 52 and the cylindrical housing 51. The sensing portion 52 within which a recess is formed is provided at its leading end part with a diaphragm portion 54 for detecting a pressure. But, the sensor is disadvantageous in the unpractical construction because the sensing portion 52 is made up of a ceramic material against a recent trendy in which a sensing portion of a pressure sensor is made up of silicon and glass. Even though the sensing portion made us of silicon and glass is employed instead of the sensing portion 52 made up of the ceramic material. It is difficult to keep an airtight condition between the metal housing and the sensing portion made up of silicon and glass.

Document EP-A-0 167 144 discloses a pressure sensor which comprises a semiconductor strain gauge which is fixed to one end of a glass base in the centre of which a pressure introduction port is formed. The lower end of the glass base is hermetically bonded to the metal cylinder by means of a seal glass.

However, if the diaphragm portion of the pressure sensor disclosed in the above-mentioned documents Japanese Laid Open Patent Publication No. 1987-293131 and EP-A-0 167 144 breaks, the measured medium leaks within the interior space of the housing, namely to the electric signal taking outside.

Furthermore, document US-A-4 320 664 discloses a pressure sensor which is thermally compensated. For this thermal compensation the sensor includes a temperature sensitive resistor which forms a part of the same semiconductor structure as the piezoresistive elements of the sensor.

SU-A-746 217 discloses a pressure sensor comprising a diaphragm portion projecting into the flow passage of a measured medium, a sensing portion having electrically conductive portion provided along silicon plates so as to transmit the electrical signal of a strain gauge and an electrical signal output portion for outputting the electrical signal which is provided within the interior space of a housing.

The present invention is directed to solving the above-mentioned problems and has for its object to provide a semiconductor pressure sensor which has a sensing portion provided with a diaphragm portion and made up of silicon and glass and in which the measured medium is prevented from leaking to the electric signal taking-out side even if the diaphragm portion including the detecting means should be broken.

For accomplishing the above-mentioned object, the present invention provides a semiconductor pressure sensor according to claim 1.

The above and other objects and advantages of the present invention will become more apparent from the following description of the invention with reference to the attached drawings.

Figure 1 is a sectional view showing a general construction of a semiconductor pressure sensor as one embodiment of the present invention;

Figure 2 is a sectional view of a principal portion of the embodiment shown in Fig. 1;

Figure 3 is a diagram showing the relation between the coefficient of thermal expansion and the maximum shear stress of a solder glass;

Figure 4 is a sectional view of a principal portion showing another embodiment of the present invention;

Figure 5 is a sectional view of a principal portion showing a further embodiment of the present invention;

Figure 6 is a sectional view on A-A line in Fig. 5;

Figure 7 is a plan view of a sensing portion of the embodiment shown in Fig. 5;

Figure 8 is a partial sectional view showing another embodiment of the present invention;

Figure 9 is a schematic view showing a construction of a refrigerating cycle for an automobile to which the present invention is applied;

Figure 10 is a partial sectional view of a semiconductor pressure sensor of the embodiment shown in Fig. 9;

Figure 11 is a sectional view showing a sensing portion of the semiconductor pressure sensor shown in Fig. 10;

Figure 12 is a circuit diagram showing a circuit for detecting a pressure and a temperature of a refrigerant by means of the semiconductor pressure sensor shown in Fig. 10;

Figure 13 is a characteristic diagram showing an output condition of a temperature detecting terminal portion in the circuit shown in Fig. 12; and

Figure 14 is a sectional view showing a conventional semiconductor pressure sensor.

Now the present invention will be explained with reference to the drawings hereinafter.

Fig. 1 is a schematic sectional view showing the first embodiment of the present invention, and Fig. 2 is a sectional view of a principal portion of the first embodiment thereof. The first embodiment of the present invention will be explained With

reference to Figs. 1 and 2. In Fig. 1, symbol 1 designates a single crystal silicon (Si) substrate which is provided with a diaphragm portion 3 and a strain gauge 5 and is joined with a support plate 7 made of glass having a characteristic similar to the coefficient of thermal expansion of the single crystal silicon substrate 1 like borosilicate glass (name used in trade : Pyrex-glass) so as to sandwich the opposite sides of the strain gauge 5 therebetween, to form a stick-like sensing portion 2 having a square cross section and to have a facedown construction. Symbol 9 designates a housing made of metal such as a Fe-Ni-Co system alloy(name used in trade : Kovar) or a Ni-Fe system alloy (name used in trade : 42-alloy). The sensing portion 2 is fixedly secured within a cylindrical portion 9A, which is formed in the housing 9 as a reception portion for introducing a measured pressure medium, by means of solder glass 11 so as to provide an airtight seal (called a hermetic seal) between the outer circumferential surface of the sensing portion 2 and the inner circumferential surface of the cylindrical portion 9A. Symbol 17 designates a bonding wire led out of the substrate 1, which serves to transmit an electric signal generated in the strain gauge 5 within the substrate 1 to a substrate 19 provided with an amplifier circuit (a hybrid IC in this embodiment) through a chip terminal 18 made of aluminum. This substrate 19 is accommodated within a chamber portion 9B formed in the upper end of the housing 9, and an electric signal amplified by the amplifier circuit therein is output outside the sensor through a pin 21 and a terminal 23 disposed in a connector area. A connector case 25 is made of resin and is fixedly secured at the outer circumferential surface 25A of its bottom portion to the housing 9 by means of a caulked portion 9C formed in the upper end of the housing 9. A resin lid 27 is fixedly bonded to the connector case 25. The pin 21 and the terminal 23 are connected each other by means of soldering. The substrate 19 is fixedly bonded within the chamber portion 9B of the housing 9. Symbol 9D designates a threaded portion which is used to be threadably secured to a housing on a measured side.

Fig. 2 is a sectional view of the principal portion (the sensing portion 2) of the first embodiment. Symbol 8 and 10 designate SiO_2 layers, symbol 12 designates a low resistivity Poly-Si layer which provides a conductive portion for electrically connecting the strain gauge 5 to an Al bonding pad 15, symbol 13 designates a high resistivity Poly-Si layer for joining the glass support plate 7 and the Si substrate 1 to each other, symbol 14 designates a high resistivity Poly-Si layer for use in insulation, symbol 15 designates the Al bonding pad, symbol 16 designates a vacuum chamber as a reference pressure chamber formed by etching the high resistivity Poly-Si layer 13, and symbol 17 designates the bonding wire.

Then, the hermetically seal formed of the above-mentioned solder glass 11 will be explained.

This embodiment is particularly intended to provide a method how both the Si substrate 1 and the glass support plate 7 forming the sensing portion 2 are joined with the metal housing 9 through the hermetic seal. After various investigations about this task, by paying attention to the coefficient of thermal expansion of Si being 31 x $10^{-7}/{}^\circ C$ and the coefficient of thermal expansion of the Pyrex glass used as the glass for the support plate 7 being 32.5 x $10^{-7}/{}^\circ C$, the housing 9 is made up of Kovar(the coefficient of thermal expansion 52 - 54 x $10^{-7}/{}^\circ C$) having a good conformity to the coefficient of thermal expansion of the sensing portion 2 or the 42-alloy (the coefficient of thermal expansion being similar to that of Kovar) and a solder glass is employed for providing the hermetic seal therebetween. However, in case that the coefficients of thermal expansion of the sensing portion 2, of the solder glass 11 and of the housing 9 are mismatched, the sensing portion 2 is subjected to an excessive stress which causes a breakage of the sensing portion 2.

In relation to that, in the case that the housing 9 is made up of the Kovar and the glass support plate 7 is made up of the Pyrex-glass, a stress analysis about a maximum shear stress of the solder glass 11 by the FEM (the finite element method) provides the result as shown in Fig. 3. According to this analysis result, the coefficient of the solder glass 11 is required to be about 40 - 50 x $10^{-7}/{}^\circ C$ because the breaking strength of the Pyrex-glass is 400 Kg f/cm^2. Therefore, this embodiment employs the value of, for example 41 x $10^{-7}/{}^\circ C$ as the coefficient of thermal expansion thereof.

Now, the operation of the first embodiment will be explained. When the sensing portion 2 is put into the measured pressure medium, a pressure of the medium is applied to the diaphragm portion 3. Thereupon, the diaphragm portion 3 is displaced and the stress depending on this displacement is applied to the strain gauge 5 to generate an electric signal according to the pressure. The electric signal is output to the amplifier circuit mounted on the substrate 19, through the low resistivity Poly-Si layer 12, the A, bonding pad 15 and the bonding wire 17. The electric signal amplified by the amplifier circuit is adapted to be output to an unillustrated outer device (for example a computer) through the pin 21 and the terminal 23.

As explained above, according to the first embodiment, since the sensing portion 2 including the strain gauge 5 and the diaphragm portion 3 is fixedly secured to the housing 9 by means of the

solder glass 11 so that the portion (Al bonding pad 15) provided on the sensing portion 2 for taking out the electric signal is isolated from the pressure, it is possible to give a sufficient length to the airtight sealing portion made of the solder glass 11 with respect to the cylindrical portion 9A of the housing 9 and to remarkably improve the sealing capability between the measured medium side and the chamber portion 9B side. Further, since the airtight sealing portion for isolating the electric signal taking out portion from the pressure medium is made up of the solder glass 11, it is applicable to almost any kinds of pressure medium and to such a portion which needs to have a high airtightness. If the diaphragm portion including the strain gauge 5 and so on should be broken, advantageously the pressure medium is prevented from leaking to the electric signal taking out side (where the Al bonding pad 15 and the bonding wire 17 are disposed) because the sensing portion itself serves as a sealing member. Further, it may be possible to mount the amplifier and so on on the Si substrate 1 instead of on the substrate 19 so as to be integrated as one-chip IC.

Incidentally, instead of the facedown construction of this embodiment in, which the Si substrate 1 is joined on its strain gauge side to the glass support seat 7, as shown in Fig. 4, it may be joined thereto on its other side opposed to the strain gauge side.

Further, instead of the electrical connection according to this embodiment in which the strain gauge 5 is electrically connected to the Al bonding pad 15 as an electric signal output means and to the bonding wire 17 through the low resistivity Poly-Si layer 12 as shown in Fig. 2, the strain gauge 5 may be electrically connected thereto through any other conductive member besides the low resistivity Poly-Si layer. For example, as shown in Fig. 5, when the vacuum chamber 16 is formed by etching the high resistivity Poly-Si layer 13, simultaneously a channel is formed by means of etching a metal film. Then, a contact hole is formed by etching a predetermined position of the SiO_2 layer and a metal film 15 is formed of Al and the like in the channel thinner than the high resistivity Poly-Si layer 13. The bonding wire 17 is connected to the metal film 15. In that way, by using the low resistivity metal film 15, it becomes possible to prevent a lowering of the sensitivity which might be caused by a loss of applied voltage. Fig. 6 is a sectional view on A-A line in Fig. 5, and Fig. 7 is a plan view of a principal portion without the support plate 7 in Fig. 5.

Further, instead of the housing 9 the whole of which is made up of the Kovar or the 42-alloy, as shown in Fig. 8, the housing 9 may have such a constitution that only its portion brought into contact with the solder glass 11 is provided with a collar 28 made of the Kovar or the 42-alloy and its other portion is made of steel (for example carbon steel).

Next, an embodiment will be explained in which the present invention is applied to a refrigerating cycle for an automobile air conditioner. Symbol 31 designates a compressor, symbol 33 designates a condenser, symbol 35 designates a receiver, symbol 37 designates an expansion valve, and symbol 39 designates an evaporator. In this refrigerating cycle, a semiconductor pressure sensor 100 according to this refrigerating cycle apparatus is disposed in a refrigerant pipe on the low pressure side between the evaporator 39 and the compressor 31 so as to detect both a pressure and a temperature of the refrigerant. Besides, the semiconductor pressure sensor 100 may be disposed in a refrigerant pipe on the high pressure side between the receiver 35 and the expansion valve 37 as required for control.

Fig. 10 is a partial sectional view of the semiconductor pressure sensor 100 attached to the refrigerant pipe 41. The semiconductor pressure sensor 100 is fixedly secured to the refrigerant pipe 41 by attaching its housing 9 to the refrigerant pipe 41 through an O-ring 43 by means of a screw 45 thereof. The sensing portion 2 of the semiconductor pressure sensor 100 has such a constitution as for the Si substrate 1 to be sandwiched between two support plates 7a, 7b made of the Pyrex-glass. Between the sensing portion 2 and the cylindrical collar 28 (a portion of the housing 9) made of the Kovar fitted to the inner circumferential surface of the cylindrical portion 9A of the housing 9 there is provided a hermetic seal made of the solder glass 11. The sensing portion 2 is projected from the leading portion of the collar 28 so that the pressure and the temperature of the refrigerant can be measured directly. The collar 28 is provided with a wire netting 47 for protecting the sensing portion 2. Therefore, the sensing portion 2 detects the pressure and the temperature of the refrigerant through the wire netting 47. The diaphragm portion 3 is located on such a side of the Si substrate 1 of the sensing portion 2 as not to be influenced by a dynamic pressure of the flow of the refrigerant indicated by the directed line in Fig. 10 with respect to the refrigerant flow. Accordingly, since the diaphragm portion 3 of the sensing portion 2 is directly brought into contact with the refrigerant passing through the wire netting 47 and is located at such a position as not to be influenced by the dynamic pressure of the refrigerant, it is possible to detect the pressure of the refrigerant correctly. Further, since the sensing portion 2 is projecting from the housing 9 and the collar 28, it is possible to detect the temperature of the refrigerant without

being influenced by a heat conduction from the housing 9 and the collar 28.

Fig. 11 is a sectional view of the sensing portion 2. As shown in Fig. 11, between the Si substrate 1 and the support plate 7a made of the Pyrex-glass there is provided the vacuum chamber 16 formed by the joint Poly-Si layer 13 between the Pyrex-glass plate 7a and the SiO_2 layer 10 formed on the Si substrate 1 as an insulator membrane similarly to that shown in Fig. 5. The Si substrate 1 is provided on its one side with the diaphragm portion 3 and on its other side With the strain gauge 5 (composed of four strain gauges 5a - 5d provided in a circuit described later). The strain gauge 5 is connected to an aluminum electrode 15 through a diffusion lead 5'.

Further, a circuit for detecting the pressure and the temperature of the refrigerant by means of the semiconductor pressure sensor 100 will be explained.

Fig. 12 is a circuit diagram of the circuit. In Fig. 12, the strain gauges 5a - 5d are arranged so that the respective resistance values thereof change according to the pressure condition of the refrigerant acting on the sensing portion 2 shown in Fig. 10 and simultaneously are variable according to the temperature of the sensing portion 2. One pair of strain gauges 5b, 5d arranged diagonally to each other are adapted to increase their resistance values according to the pressure, and the other pair of strain gauges 5a, 5c arranged diagonally to each other are adapted to decrease their resistance values according to the pressure. As a result, the resistance value between both points of A and D is independent of the pressure.

Between a power source V_{cc} and an earthing point GND there is provided, a series circuit comprising resistors R01, R02 and R03. Respective constant-potentials V_K, V_M at the connection points K, M between the resistors R01, R02 and between the resistors R02, R03 are settled by a divided voltage. The power source V_{cc} is connected to the point A as the connection point between the strain gauges 5a and 5d of the Wheatstone bridge through a resistor R05. The potential together with the potential at the point K, i.e. the output from the operation amplifier OP-1 is supplied to the connection point B between the strain gauges 5a and 5d and to the connection point C between the strain gauges 5c and 5d respectively through the respective resistors R07, R08. That is, the operation amplifier OP-1 and the resistor R05 serve as a constant current source for the bridge circuit comprising the strain gauges, and the resistors R07 and R08 provide a circuit to roughly adjust an offset output voltage of the bridge circuit.

The output voltage V_c at the output point C of the Wheatstone bridge comprising the strain gauges is supplied to an operation amplifier OP-2. The operation amplifier OP-2 is provided for preventing circuit side current from flowing into the bridge circuit or from flowing reversely. The output signal from this operation amplifier OP-2 is supplied to an operation amplifier OP-3 together with the output voltage V_c from the point B of the bridge circuit through a resistor R09. Then, a transistor Tr_1 is controlled by the output from the operation amplifier OP-3. The operation amplifier OP-3, resistor R09 and transistor Tr_1 serve to convert an output voltage "V_B - V_C" of the Wheatstone bridge to a current output.

Since the transistor Tr_1 controlled by the output signal from the operation amplifier OP-3 is connected at its collector to the power source V_{CC} through a resistor R11, the signal in the collector circuit of the transistor Tr_1 is supplied to an operation amplifier OP-4. The operation amplifier OP-4 forms an amplifier circuit together with resistors R11, R12, R13 so as to amplify the current output from the operation amplifier OP-3 and to obtain a pressure detection signal V_p . Thereupon, the amplification factor of the circuit containing the operation amplifier OP-4 is defined according to the ratio between the resistor R12 and the resistor R09.

A signal V_D at a point D as the connection point between the strain gauges 5b and 5c is supplied to an operation amplifier OP-5 together with a reference voltage V_M set at a point M. The operation amplifier OP-5 detects a change of the voltage V_D adapted to change according to a temperature at the point D together with a resistor 21 so as to convert the change to a current output and to control a transistor Tr_2 by an output signal from the operation amplifier OP-5. A signal in the collector circuit of the transistor Tr_2 is supplied to an operation amplifier OP-6 together with the reference voltage V_K at a point K. The operation amplifier OP-6 comprises an amplifier circuit together with resistors R22, R23, R24 and serves to amplify the output signal from the operation amplifier OP-5 and to obtain a temperature detection output V_T.

Accordingly, in case that the pressure acting on the sensing portion 2 changes, the potential V_C at the output point C of the Wheatstone bridge comprising the strain gauges changes according to this pressure change so as to output the pressure detection signal V_p. Since the potential V_D at the point D changes linearly with respect to the temperature as shown in Fig. 13, the temperature detection signal V_T can be obtained by using the circuit of the operation amplifier OP-5 as a circuit for converting the potential V_D at the point D to such a signal which can change nearly from an earthing voltage (GND) to a power source potential (V_{CC}).

Incidentally, instead of the above-mentioned embodiment in which the pressure and the temperature of the pressure medium are adapted to be detected by use of the strain gauges 5a - 5d, a temperature detection element may be arranged near the strain gauges 5a - 5d on the Si substrate 1 so as to detect the temperature of the medium thereby.

Claims

1. A semiconductor pressure sensor adapted to measure the pressure of a medium, comprising
   a sensing portion (2) composed of a glass support plate (7) and a silicon substrate (1) disposed thereon and provided with a diaphragm portion (3) which is brought into contact with the measured medium and is displaceable in accordance with the pressure thereof,
   a detecting means (5) disposed within said sensing portion (2) so as to detect a displacement of said diaphragm portion (3) to generate an electric signal according to the pressure;
   a housing (9) having an interior space including an accomodation portion (9A) for accomodating said sensing portion, at least one predetermined portion (9A, 28) of said accomodation portion being made of metal; and
   a solder glass (11) provided between said predetermined portion (9A, 28) of said housing and a predetermined portion of said sensing portion so as to hermetically seal the interior space (9B) of said housing with respect to said measured medium,
   characterized in that
   said diaphragm portion (3) projects into the flow passage of the measured medium,
   said sensing portion has an electrically conductive portion (12) provided along said silicon substrate so as to transmit said electric signal of said detecting means (5);
   an electric signal output portion (15) for outputting said electric signal of said electrically conductive portion (12) is provided within said interior space (9B) of said housing (9); and
   a portion of said silicon substrate (1) between said diaphragm portion (3) and said output portion (15) is sealed with said glass support plate (7) so that the sensing portion (2) itself serves as a sealing member of the interior space (9B) with respect to said measured medium.

2. A semiconductor pressure sensor according to claim 1, wherein said portion of the silicon substrate (1) is joined to said glass support plate (7).

3. A semiconductor pressure sensor according to claim 1, wherein said portion of the silicon substrate (1) is joined to said glass support plate (7) through a layer (13) for forming a vacuum chamber (16).

4. A semiconductor pressure sensor according to claim 1, 2 or 3, wherein said conductive portion (12) is made of a low resistivity Poly-Si layer.

5. A semiconductor pressure sensor according to any preceding claim, wherein the coefficient of thermal expansion of said metal portion of said housing is similar to the coefficient of thermal expansion of said silicon substrate (1) and of said glass support plate (7), and the coefficient of thermal expansion of said solder glass (11) has an intermediate value lying between both the coefficients of thermal expansion of said glass support plate and of said metal portion.

6. A semiconductor pressure sensor according to claim 5, wherein said metal portion of said housing is made up of Fe-Ni-Co system alloy, and the glass for said support plate is borosilicate glass.

7. A semiconductor pressure sensor according to claim 5, wherein said metal portion of said housing is made up of Ni-Fe system alloy, and the glass for said support plate is borosilicate glass.

8. A semiconductor pressure sensor according to any preceding claim, wherein said predetermined portion of said housing is provided with a metal collar.

9. A semiconductor pressure sensor according to any preceding claim, wherein said diaphragm portion (3) is provided at such a position in said sensing portion as not to he influenced by a dynamic pressure of said measured medium.

10. A semiconductor pressure sensor according to any preceding claim, wherein said detecting means (5) includes a strain gauge disposed at the position opposed to said diaphragm portion within said silicon substrate (1).

11. A semiconductor pressure sensor according to any preceding claim, wherein said semiconductor sensor pressure is adapted to detect a refrigerant pressure within a refrigerant pipe employed in a refrigerating cycle for an auto-

mobile including an evaporator, a compressor, a condenser, a receiver, an expansion valve and a refrigerant pipe connecting them.

12. A semiconductor pressure sensor according to claim 11, wherein said sensing portion has such a constitution that said silicon substrate (1) is sandwiched between a pair of glass support plates at least at its portion to be hermetically sealed by said solder glass, that the portion projected into said refrigerant is composed of said silicon substrate and one of said paired glass support plates and that the portion of said silicon substrate provided with said diaphragm is exposed to said refrigerant.

13. A semiconductor pressure sensor according to any preceding claim, wherein said detecting means (5) includes a temperature detecting means for detecting a temperature of said measured medium at the projected portion of said sensing portion.

14. A semiconductor pressure sensor according to any preceding claim, wherein said semiconductor pressure sensor further comprises a protection cap provided in said housing so as to permit said measured medium to pass therethrough, said cap protecting the projected portion of said sensing portion.

Patentansprüche

1. Halbleiter-Drucksensor, der zur Messung des Drucks eines Mediums ausgelegt ist, mit

   einem Erfassungsabschnitt (2), der aus einer Glasträgerplatte (7) und einem darauf angeordneten Siliciumsubstrat (1) besteht und mit einem Membranabschnitt (3) versehen ist, der mit dem gemessenen Medium in Kontakt gebracht wird und in Übereinstimmung mit dessen Druck verlagerbar ist,

   einer Detektoreinrichtung (5), die innerhalb des Erfassungsabschnitts (2) angeordnet ist, um eine Verlagerung des Membranabschnitts (3) zur Erzeugung eines dem Druck entsprechenden elektrischen Signals zu erfassen,

   einem Gehäuse (9) mit einem Innenraum, der einen Unterbringungsabschnitt (9A) für die Aufnahme des Erfassungsabschnitts aufweist, wobei zumindest ein vorbestimmter Abschnitt (9A, 28) des Unterbringungsabschnitts aus Metall hergestellt ist; und

   einem Lötmittelglas (11), das zwischen dem vorbestimmten Abschnitt (9A, 28) des Gehäuses und einem vorbestimmten Abschnitt des Erfassungsabschnitts vorgesehen ist, um den Innenraum (9B) des Gehäuses bezüglich des gemessenen Mediums hermetisch abzudichten,

   dadurch gekennzeichnet, daß

   der Membranabschnitt (3) in den Strömungsdurchgang des gemessenen Mediums vorragt,

   daß der Erfassungsabschnitt einen elektrisch leitenden Abschnitt (12) besitzt, der entlang des Siliciumsubstrats vorgesehen ist, um das elektrische Signal der Detektoreinrichtung (5) zu übertragen;

   daß ein elektrischer Signalausgabeabschnitt (15) zum Abgeben des elektrischen Signals des elektrisch leitenden Abschnitts (12) in dem Innenraum (9B) des Gehäuses (9) vorgesehen ist, und

   daß ein Abschnitt des Siliciumsubstrats (1) zwischen dem Membranabschnitt (3) und dem Ausgabeabschnitt (15) mit der Glasträgerplatte (7) abgedichtet ist, so daß der Erfassungsabschnitt (2) selbst als ein Dichtelement des Innenraums (9B) bezüglich des gemessenen Mediums dient.

2. Halbleiter-Drucksensor nach Anspruch 1, bei dem der Abschnitt des Siliciumsubstrats (1) mit der Glasträgerplatte (7) verbunden ist.

3. Halbleiter-Drucksensor nach Anspruch 1, bei dem der Abschnitt des Siliciumsubstrats (1) mit der Glasträgerplatte (7) über eine Schicht (13) zum Bilden einer Vakuumkammer (16) verbunden ist.

4. Halbleiter-Drucksensor nach Anspruch 1, 2 oder 3, bei dem der leitende Abschnitt (12) aus einer Schicht aus Poly-Si mit niedrigem Widerstandswert hergestellt ist.

5. Halbleiter-Drucksensor nach einem der vorhergehenden Ansprüche, bei dem der Koeffizient der thermischen Ausdehnung des metallischen Abschnitts des Gehäuses gleich groß wie der Koeffizient der thermischen Ausdehnung des Siliciumsubstrats (1) und der Glasträgerplatte (7) ist, und bei dem der Koeffizient der thermischen Ausdehnung des Lötmittelglases (11) einen Zwischenwert besitzt, der zwischen den beiden Koeffizienten der thermischen Ausdehnung der Glasträgerplatte und des metallischen Abschnitts liegt.

6. Halbleiter-Drucksensor nach Anspruch 5, bei dem der metallische Abschnitt des Gehäuses aus einer Legierung des Fe-Ni-Co-Systems hergestellt ist und bei dem das Glas für die Trägerplatte Borsilikat-Glas ist.

7. Halbleiter-Drucksensor nach Anspruch 5, bei dem der metallische Abschnitt des Gehäuses aus einer Legierung des Ne-Fe-Systems hergestellt ist und bei dem das Glas für die Trägerplatte Borsilikat-Glas ist.

8. Halbleiter-Drucksensor nach einem der vorhergehenden Ansprüche, bei dem der vorbestimmte Abschnitt des Gehäuses mit einem metallischen Kragen versehen ist.

9. Halbleiter-Drucksensor nach einem der vorhergehenden Ansprüche, bei dem der Membranabschnitt (3) an einer derartigen Position in dem Erfassungsabschnitt vorgesehen ist, daß er nicht durch einen dynamischen Druck des gemessenen Mediums beeinflußt wird.

10. Halbleiter-Drucksensor nach einem der vorhergehenden Ansprüche, bei dem die Detektoreinrichtung (5) einen Belastungsmesser bzw. Dehnungsmesser enthält, der an der Position angeordnet ist, die dem Membranabschnitt innerhalb des Siliciumsubstrats (1) gegenüberliegt.

11. Halbleiter-Drucksensor nach einem der vorhergehenden Ansprüche, bei dem der Halbleiter-Drucksensor für die Erfassung des Drucks eines Kühlmittels innerhalb eines Kühlmittelrohrs bzw. -schlauchs ausgelegt ist, das bzw. der bei einem Kühlmittelzyklus für ein Kraftfahrzeug mit einem Verdampfer, einem Kompressor, einem Verdichter, einem Empfänger, einem Ausdehnungsventil und einem diese verbindenden Kühlmittelrohr bzw. -schlauch eingesetzt wird.

12. Halbleiter-Drucksensor nach Anspruch 11, bei dem der Erfassungsabschnitt eine derartige Gestaltung besitzt, daß das Siliciumsubstrat (1) sandwichartig zwischen einem Paar von Glasträgerplatten zumindest an einem Abschnitt eingeschlossen ist, um hermetisch durch das Lötmittelglas abgedichtet werden, wobei der in das Kühlmittel vorragende Abschnitt aus dem Siliciumsubstrat und einer der paarweise zusammengefaßten Glasträgerplatten besteht und der mit der Membran versehene Abschnitt des Siliciumsubstrats dem Kühlmittel ausgesetzt ist.

13. Halbleiter-Drucksensor nach einem der vorhergehenden Ansprüche, bei dem die Erfassungseinrichtung (5) eine Temperaturerfassungseinrichtung zum Erfassen einer Temperatur des gemessenen Mediums bei dem vorstehenden Abschnitt des Erfassungsabschnitts enthält.

14. Halbleiter-Drucksensor nach einem der vorhergehenden Ansprüche, wobei der Halbleiter-Drucksensor weiterhin eine in dem Gehäuse vorgesehene Schutzkappe aufweist, um den Durchgang des gemessenen Mediums hierdurch zu ermöglichen, wobei die Kappe den vorstehenden Abschnitt des Erfassungsabschnitts schützt.

Revendications

1. Capteur de pression à semi-conducteur prévu pour mesurer la pression d'un milieu comprenant, une partie de détection (2) constituée d'une plaque de support en verre (7) et d'un substrat de silicium (1) disposé sur celle-ci et munie d'une partie de membrane (3) qui est amenée en contact avec le milieu à mesurer et déplaçable en conformité avec la pression de celui-ci,

un moyen de détection (5) disposé à l'intérieur de ladite partie de détection (2) de façon à détecter un déplacement de ladite partie de membrane (3) afin de produire un signal électrique selon la pression,

un logement (9) ayant un espace intérieur comportant une partie de réception (9A) pour recevoir ladite partie de détection, au moins une partie prédéterminée (9A, 28) de ladite partie de réception étant constituée de métal et un verre à souder (11) prévu entre ladite partie prédéterminée (9A, 28) dudit logement et une partie prédéterminée de ladite partie de détection de façon à isoler hermétiquement l'espace intérieur (98) dudit logement par rapport audit milieu à mesurer,

caractérisé en ce que

ladite partie de membrane (3) dépasse dans le passage d'écoulement du milieu à mesurer,

ladite partie de détection comporte une partie électriquement conductrice (12) prévue suivant ledit substrat de silicium de façon à transmettre ledit signal électrique dudit moyen de détection (5),

une partie de sortie de signal électrique (15) pour sortir ledit signal électrique de ladite partie électriquement conductrice (12) est prévue à l'intérieur dudit espace intérieur (9B) dudit logement (9), et

une partie dudit substrat de silicium (1) entre ladite partie de membrane (3) et ladite partie de sortie (15) est fermée avec ladite partie de support de verre (7) de sorte que la partie de détection (2) serve elle-même d'élément d'étanchéité de l'espace intérieur (9B) par rapport audit milieu à mesurer.

2. Capteur de pression à semi-conducteur selon la revendication 1, dans lequel ladite partie du substrat de silicium (1) est raccordée à ladite plaque de support en verre (7).

3. Capteur de pression à semi-conducteur selon la revendication 1, dans lequel ladite partie du substrat de silicium (1) est raccordée à ladite plaque de support de verre (7) par l'intermédiaire d'une couche (13) pour former une chambre à vide (16).

4. Capteur de pression à semi-conducteur selon la revendication 1, 2 ou 3, dans lequel ladite partie conductrice (12) est constituée d'une couche de polysilicium à faible résistivité.

5. Capteur de pression à semi-conducteur selon l'une quelconque des revendications précédentes, dans lequel le coefficient de dilatation thermique de ladite partie métallique dudit logement est similaire au coefficient de dilatation thermique dudit substrat de silicium (1) et de ladite plaque de support en verre (7) et le coefficient de dilatation thermique dudit verre à souder (11) présente une valeur intermédiaire se trouvant entre les deux coefficients de dilatation thermique de ladite plaque de support en verre et de ladite partie métallique.

6. Capteur de pression à semi-conducteur selon la revendication 5, dans lequel ladite partie métallique dudit logement est constituée d'un alliage du système Fe-Ni-Co et le verre de ladite plaque de support est constitué de verre de borosilicate.

7. Capteur de pression à semi-conducteur selon la revendication 5, dans lequel ladite partie métallique dudit logement est constituée d'un alliage du système Ni-Fe et le verre de ladite plaque de support est constitué de verre de borosilicate.

8. Capteur de pression à semi-conducteur selon l'une quelconque des revendications précédentes, dans lequel ladite partie prédéterminée dudit logement est munie d'un collier métallique.

9. Capteur de pression à semi-conducteur selon l'une quelconque des revendications précédentes, dans lequel ladite partie de membrane (3) est prévue à une position telle dans ladite partie de détection qu'elle ne sera pas influencée par une pression dynamique dudit milieu à mesurer.

10. Capteur de pression à semi-conducteur selon l'une quelconque des revendications précédentes, dans lequel ledit moyen de détection (5) comporte une jauge de contrainte disposée à un emplacement opposé à ladite partie de membrane à l'intérieur dudit substrat de silicium (1).

11. Capteur de pression à semi-conducteur selon l'une quelconque des revendications précédentes, dans lequel ledit capteur de pression à semi-conducteur est prévu pour détecter une pression d'un réfrigérant à l'intérieur d'un tuyau de réfrigérant employé dans un cycle de réfrigération pour une automobile comportant un évaporateur, un compresseur, un condenseur, un récepteur, une soupape d'expansion et un tuyau de réfrigérant les raccordant.

12. Capteur de pression à semi-conducteur selon la revendication 11, dans lequel ladite partie de détection a une constitution telle que ledit substrat de silicium (1) est pris en sandwich entre une paire de plaques de support de verre, au moins à sa partie qui doit être hermétiquement isolée par ledit verre à souder, que la partie qui dépasse dans ledit agent réfrigérant est constituée dudit substrat de silicium et d'une des plaques de support appariées et que la partie dudit substrat de silicium munie de ladite membrane est exposée audit agent réfrigérant.

13. Capteur de pression à semi-conducteur selon l'une quelconque des revendications précédentes, dans lequel ledit moyen de détection (5) comporte un moyen de détection de température pour détecter une température dudit milieu à mesurer à la partie dépassante de ladite partie de détection.

14. Capteur de pression à semi-conducteur selon l'une quelconque des revendications précédentes, dans lequel ledit capteur de pression à semi-conducteur comprend de plus un couvercle de protection prévu dans ledit logement de façon à permettre audit milieu à mesurer de passer à travers celuici, ledit couvercle protégeant la partie dépassante de ladite partie de détection.

FIG. 1

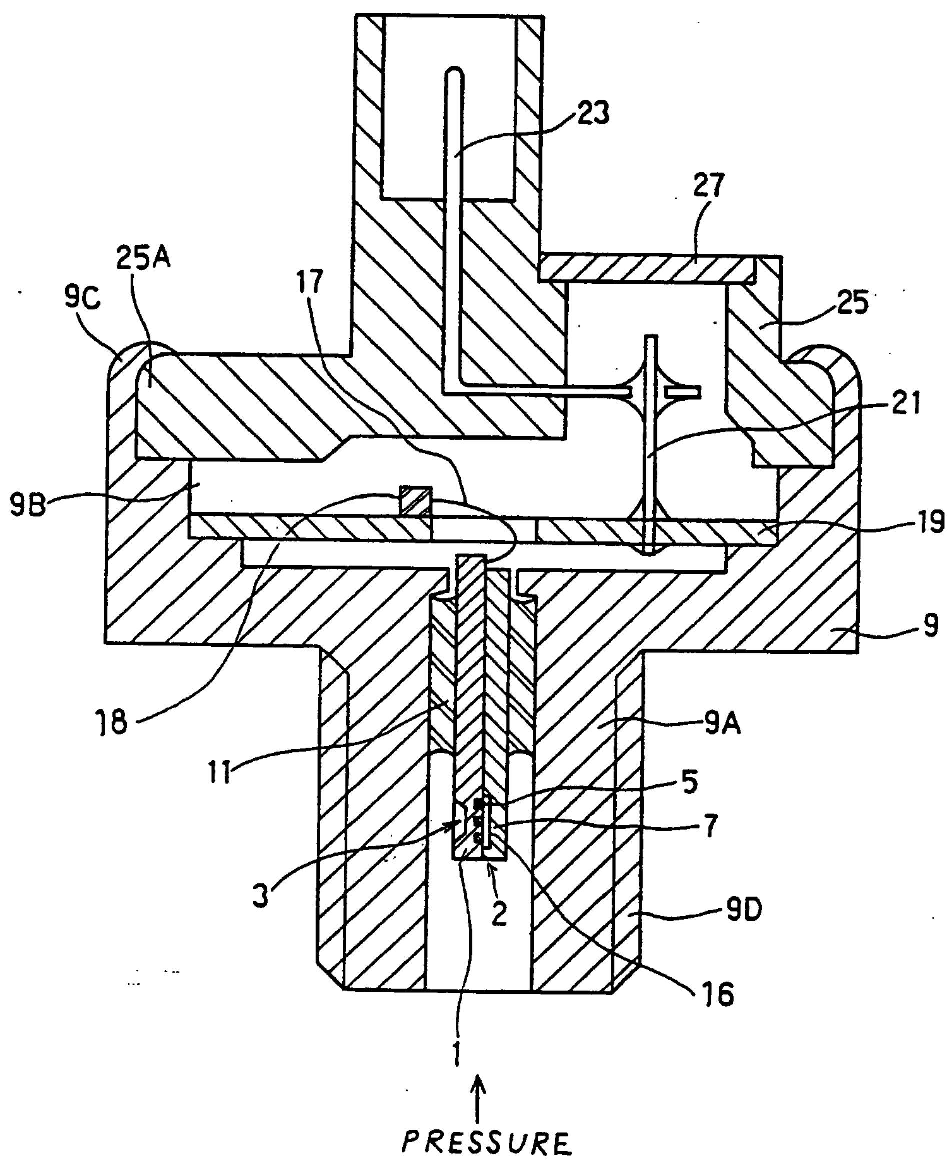


FIG. 2

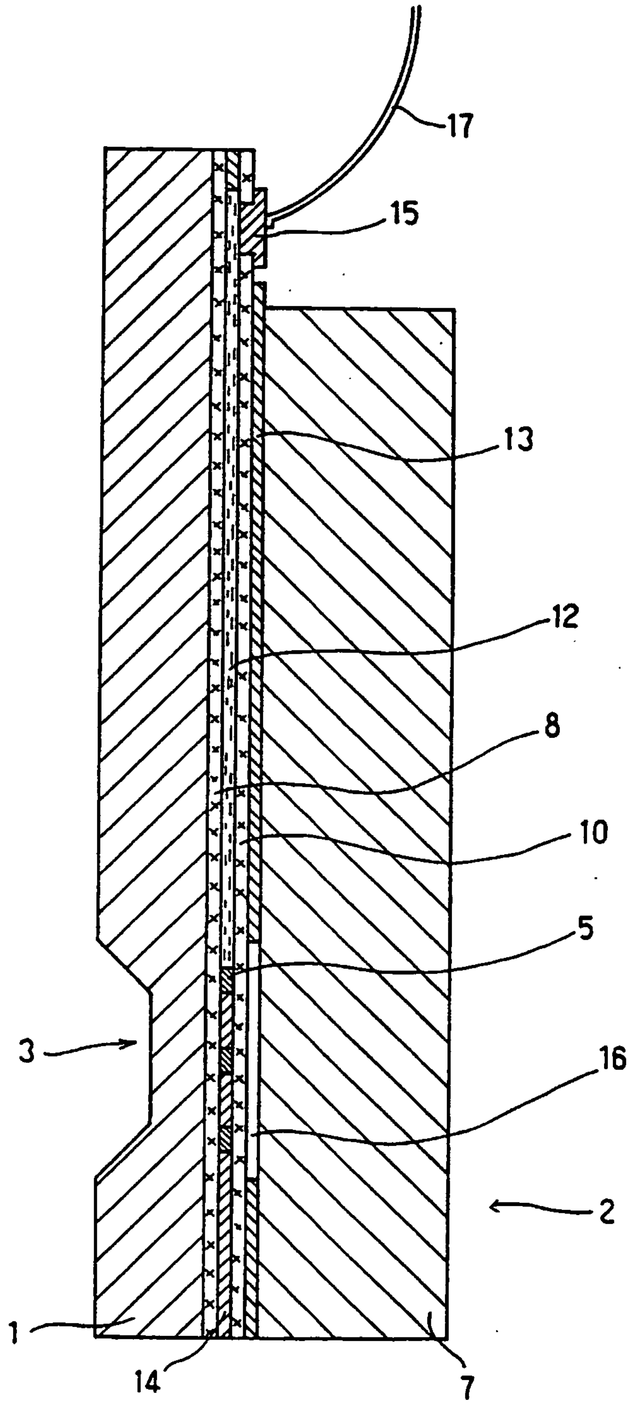


FIG.3

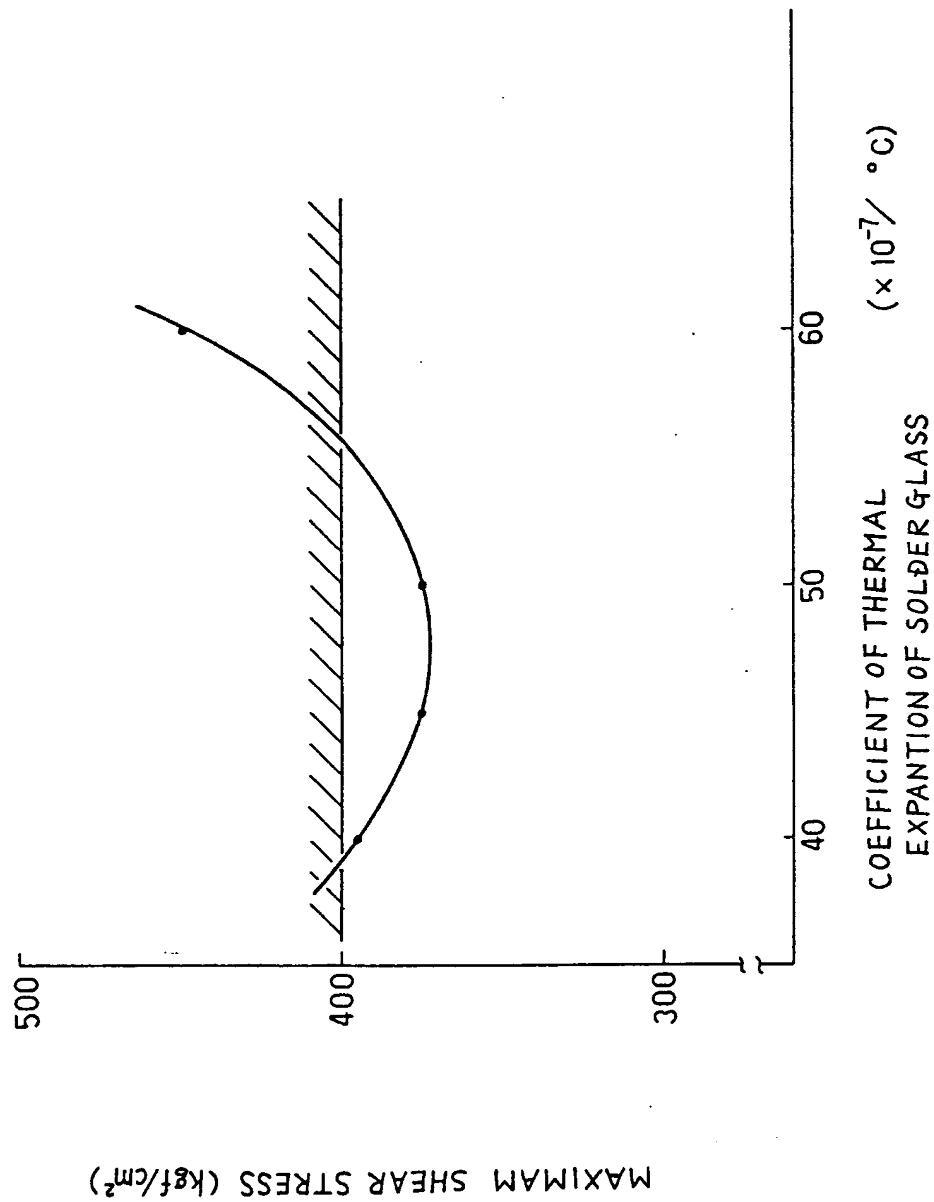

500
400
300
40
50
60
COEFFICIENT OF THERMAL
EXPANTION OF SOLDER GLASS
(× 10⁻⁷/ °C)
MAXIMAM SHEAR STRESS (kgf/cm²)

FIG.4

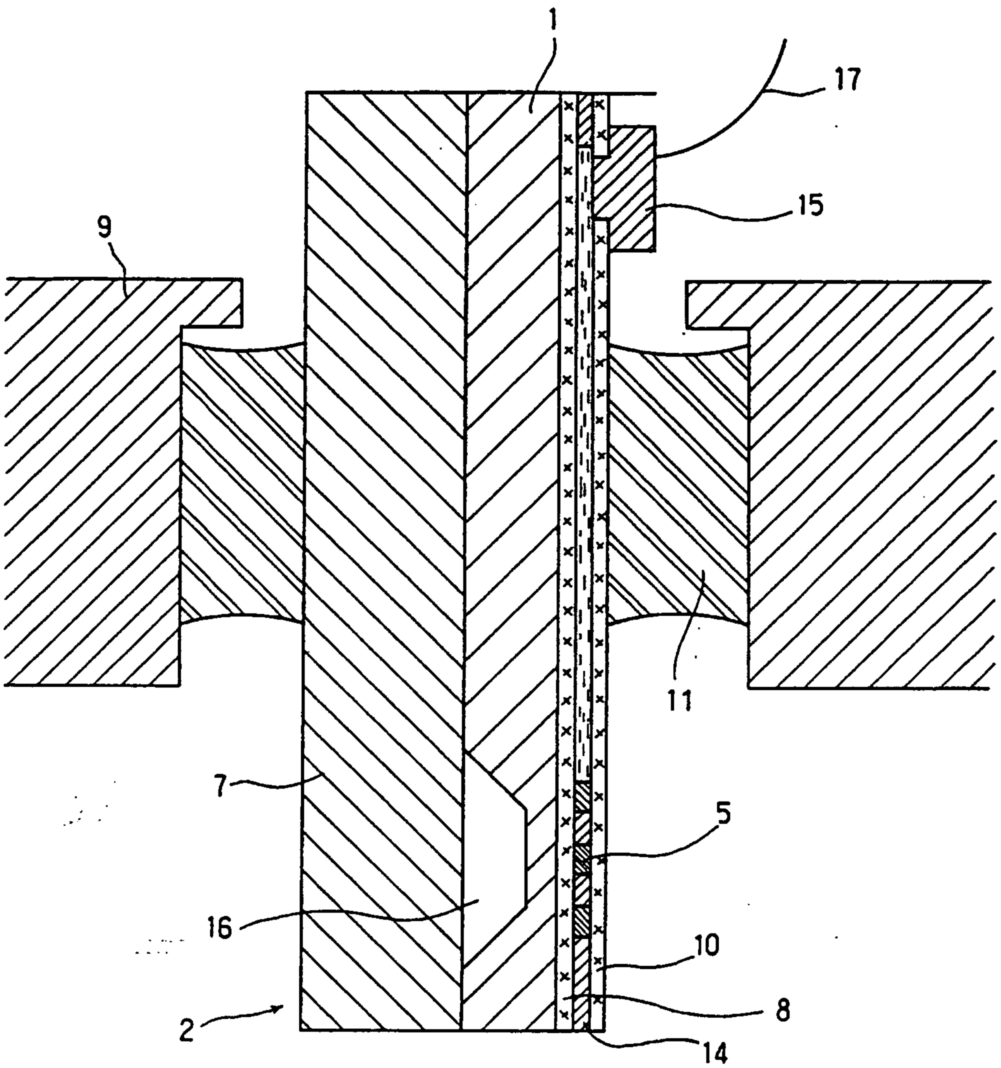


FIG.5

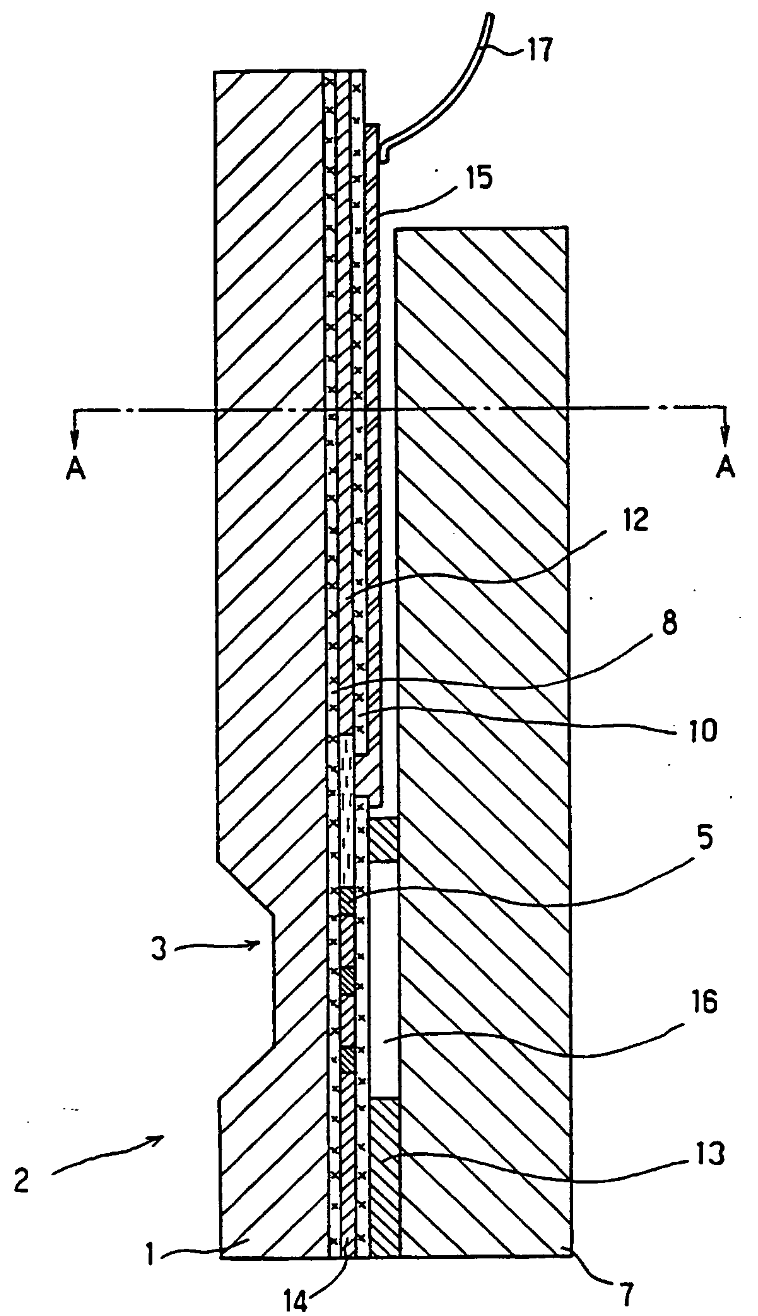


FIG.6

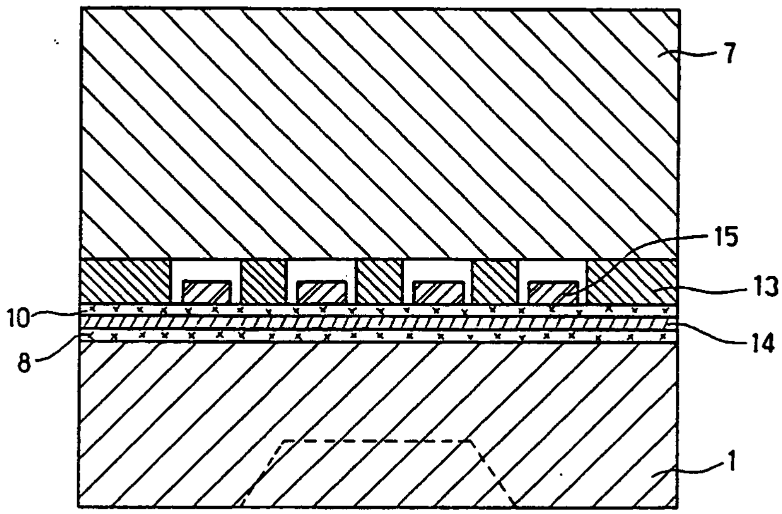


FIG.7

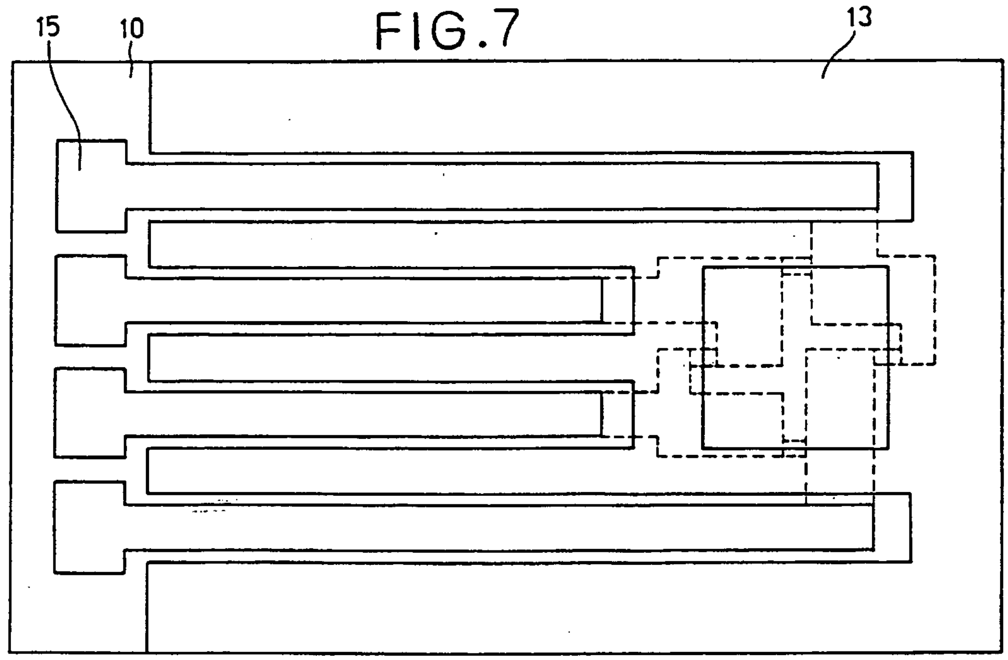


FIG.8

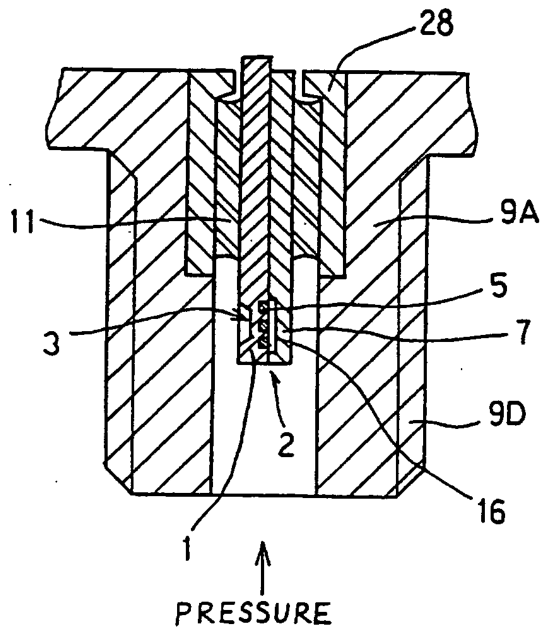


FIG.9

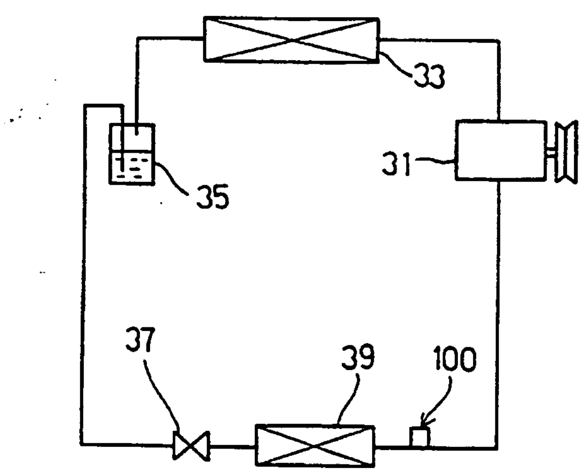


FIG.10

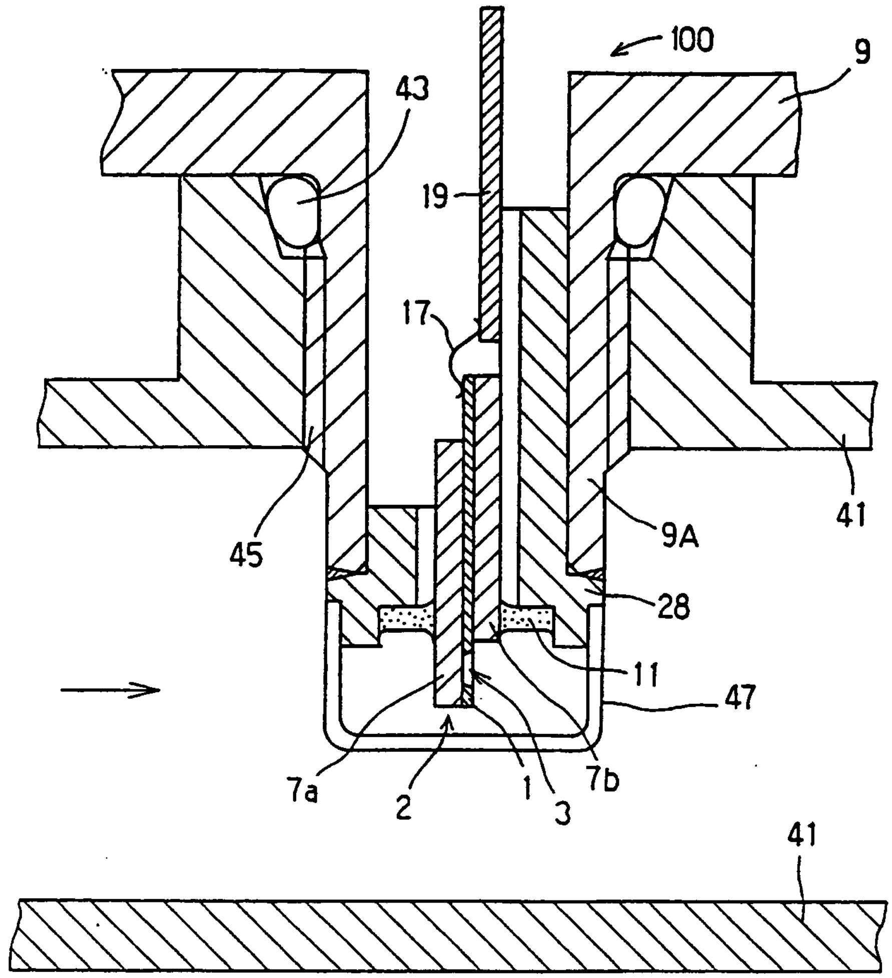

100
9
43
19
17
41
45
9A
28
11
47
7a
2
1
3
7b
41

FIG.11

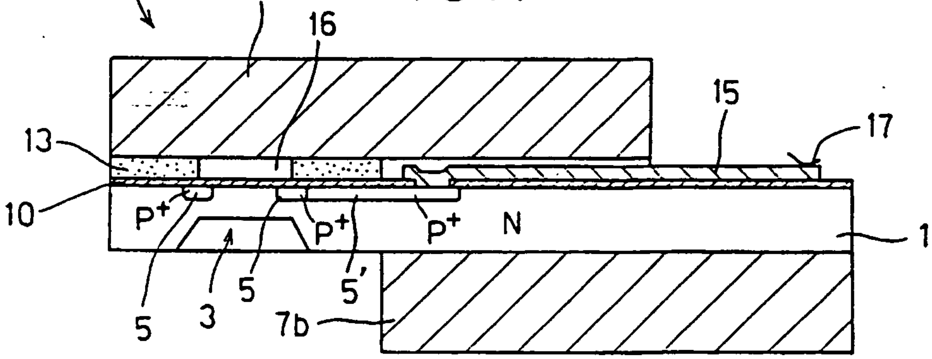

2
7a
16
15
17
13
10
P+
P+
P+
N
1
5
3
5
5'
7b

FIG.12

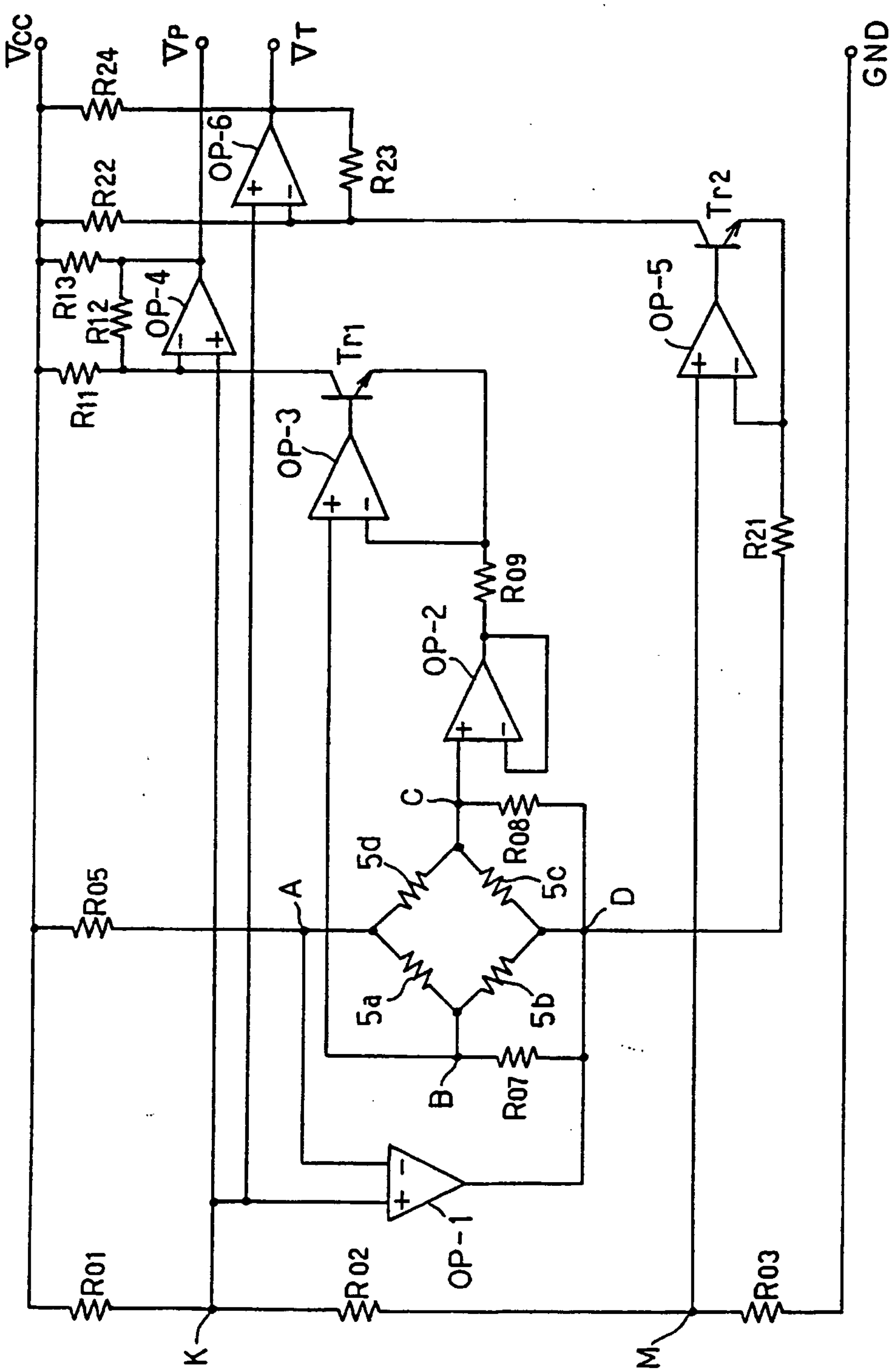

Vcc
VP
VT
GND
R24
R22
R23
OP-6
R13
R12
R11
OP-4
Tr1
OP-3
R09
OP-2
C
R08
5d
5c
A
D
R05
5a
5b
B
R07
OP-1
R01
R02
R03
K
M
OP-5
Tr2
R21

FIG.13

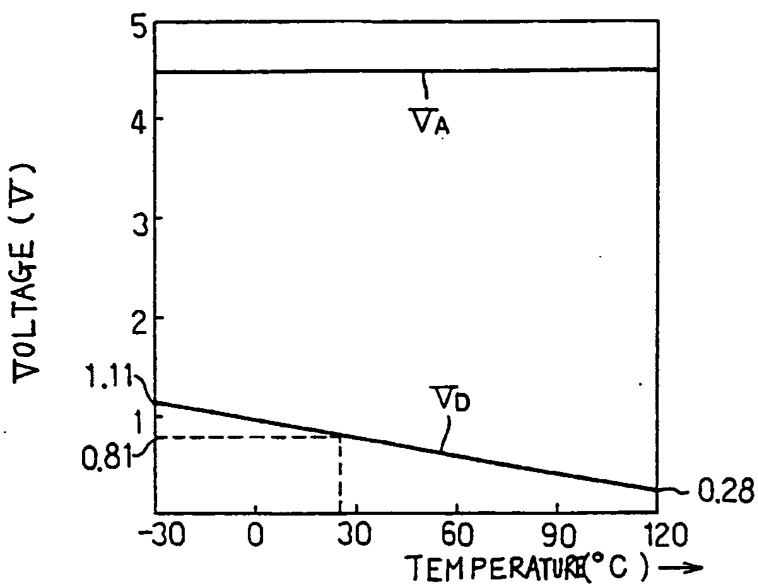
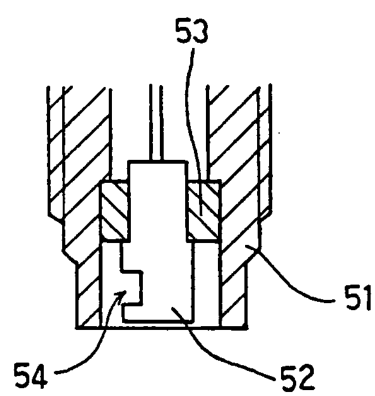

5
4
3
2
1.11
1
0.81
VOLTAGE (V)
VA
VD
0.28
-30
0
30
60
90
120
TEMPERATURE(°C) →

FIG.14


53
51
54
52